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II.

"SENSORIAL" AND "MUSCULAR" REACTIONS.

By A. R. HILL, A. B., and R. WATANABE, Ph. M.

In the course of his investigation *Ueber den Hautsinn* (Archiv für [Anatomie und] Physiologie, 1892, p. 311), Dr. M. Dessoir writes: "Ich müsste nun eigentlich mittheilen, ob von mir und meinen Versuchspersonen sensoriell oder musculär reagirt worden ist. Ich kann das leider nicht, weil keiner der Herren [8] bei Benutzung des Fingercontactes [p. 309] den Unterschied zu stande brachte." With the ordinary key ("an dem gewöhnlichen Tastapparat"), on the other hand, the two reaction-values were obtained.

It is a well-known fact that not every person examined in a psychological laboratory proves to be a capable reaction-subject. Some cannot react with any constancy; some never reach the quickness of the muscular form; some, while reacting constantly, do not conform to the Lange type. (See, *e. g.*, *Phil. Studien*, VIII. 138, 403 ff.) Into the reasons for these individual differences we do not wish here to enter. We have rather proposed to ourselves for answer the special question: Is the sensorial-muscular difference entirely conditioned by the technique of the ordinary reaction-experiment? Or can that difference be obtained from practised experimentees under other conditions: with, *e. g.*, the Dessoir finger- or the Cattell lip-key?

Our experiments were carried out in the months January to mid-March and April to June, 1893. We used the Hipp chronoscope (new pattern) in Dessoir's way (lower magnet only; pp. 306, 307); and tested the instrument by Wundt's new fall-hammer (*Phil. Studien*, VIII. 145 ff.). The apparatus was arranged on the Leipzig plan, in two rooms. Dr. Scripture, of Yale University, kindly allowed his mechanician to construct for us a Dessoir key. The stimulus was, throughout, the sound caused by the dropping of an electric hammer upon its ambos. Unfortunately, our fall-hammer was injured at the end of March, and from that time on we were compelled to rely exclusively upon the chronoscope. The previous test experiments had shown that, while the latter instrument was generally reliable, the mean variation of its control-times was apt to be somewhat greater than that of the times of the old pattern clock. This result, which is confirmed by that of some preliminary tests carried out in the Leipzig laboratory, points to the need of a thorough chronographic examination of the new chronoscope, in its four possible modes of functioning. This examination we hope to be able shortly to set on foot. Our present figures, therefore, possess: (1) no *absolute* (chronographic) value, except in so far as they are borne out by the results of other published investigations; and (2) even a *relative* value only in the rough. They are, however, sufficiently accurate for the answering of the question under investigation.

Nine persons took part in the experimentation: Miss Fanning (*F.*), Miss Hannum (*Ha.*), Messrs. Hill (*Hi.*), Irons (*I.*), Knox (*K.*), Major (*M.*), Schlapp (*S.*), Titchener (*T.*) and Watanabe (*W.*). Practice consisted in the taking, on four different days, of four series of twenty experiments of either type; the experimentee being required to direct the attention upon movement or stimulus, as the case might be.¹ The reaction-movement with the ordinary key consisted in the snapping-off of the index or second finger

(according to the constant preference of the reagent) of the right hand from the button to the table; not in the raising of the whole hand, or of hand and arm, from the key.² With the Dessoir key, it was the opening of the closed thumb and index finger of the same hand; with the Cattell lip-key (*Phil. Studien*, III. 312), the opening of the closed lips.

Our control-experiments, January-March, gave the following result: determinations recorded, each of ten experiments, twenty-two; average chronoscope reading, 186.1 σ ; average mean variation, 1.9 σ ; mean variation of average reading, 6.06 σ ; mean variation of average mean variation, 0.8 σ . All numbers in the following tables have been reduced to this average reading, except those whose authority is the chronoscope alone; these are distinguished by a prefixed *. The first column gives the name of the observer; the second the reaction-time; the third, the mean variation of the separate times; the fourth, the number of experiments; the fifth, the number of experimental series; the sixth, the mean variation of the average times obtained from the separate series:

TABLE I.

Muscular Reaction to Sound.

1	2	3	4	5	6
<i>S.</i>	123.4	12.5	29	3	3.4
<i>F.</i>	126.2	7.6	37	3	2.8
<i>Ha.</i>	111.7	8.2	66	5	6.3
<i>I.</i>	125.0	13.0	15	1	—
<i>W.</i>	123.7	16.6	27	2	3.3
<i>Hi.</i>	120.2	15.4	20	2	3.1

The seventh column in Table II. gives the time-difference between the sensorial and muscular forms.

¹ We do not understand Dessoir's remarks in this connection, p. 312.

² This form of movement, proposed by Professor Wundt, was also employed in the reaction-investigation of *Phil. Studien*, VIII. 138 ff.

TABLE II.
Sensorial Reaction to Sound.

1	2	3	4	5	6	7
<i>S.</i>	206.5	18.7	28	2	30.0	83.1
<i>F.</i>	217.0	28.0	36	3	12.6	80.8
<i>Ha.</i>	206.1	25.1	32	4	10.9	94.4
<i>I.</i>	227.3	38.7	15	1	—	102.3

No experiments were recorded for *W.* and *Hi.*
The two following tables show the results obtained with the Cattell lip-key:

TABLE III.
Muscular Reaction to Sound. Cattell Key.

1	2	3	4	5	6
<i>S.</i>	128.0	10.0	1	15	—
<i>F.</i>	129.9	15.4	3	33	1.5
<i>Ha.</i>	118.7	18.0	2	30	11.2
<i>I.</i>	123.9	15.2	4	48	8.4
<i>W.</i>	158.0	17.0	2	21	2.0
<i>Hi.</i>	122.5	11.4	2	23	13.5
<i>T.</i>	137.3	12.1	2	20	16.5
(<i>K.</i>	122.8	20.6	4	40	19.6)

TABLE IV.
Sensorial Reaction to Sound. Cattell Key.

1	2	3	4	5	6	7
<i>F.</i>	218.3	20.6	6	70	8.8	88.4
<i>Ha.</i>	243.3	34.7	3	30	2.9	124.6
(<i>I.</i>	202.3	37.1	3	34	16.2	78.4)
<i>W.</i>	250.0	13.8	3	21	14.9	92.0
<i>T.</i>	254.4	22.5	2	20	2.6	117.1
(<i>K.</i>	131.0	25.2	4	35	11.5)	

Remarks.—III. *F.* gave many premature reactions. The “sensorial” time of *S.* tended to be central (Martius), but both the extreme forms occurred, and the mean variation of the result was very large. IV. *I.* gave typical central times. The reagent himself stated that he was unable to fulfil the conditions of the sensorial reaction. The reagent *K.* made no distinction between the forms from the outset, and was not educable. His type is the muscular, but his large mean variations prove his unsuitability to function as reaction-subject. III. *W.* seems to show a slight leaning towards centrality. It is curious to compare I. *I.* with III. *I.*, but the difference is so slight that the apparatus may be to blame for it. *Hi.* gave a central (204 σ) for a sensorial time, admitting, like *I.*, his inability to concentrate his attention on the sense-impression.—It is obvious that our experiments are not directly comparable with those of Cattell (*Phil. Studien*, II. 305 ff.).

The two final tables show the results obtained with a Dessoir finger-key.

TABLE V.

Muscular Reaction to Sound. Dessoir Key.

1	2	3	4	5	6
<i>F.</i>	* 157.2	15.8	8	86	11.0
<i>I.</i>	* 152.8	14.8	3	24	5.6
<i>W.</i>	* 161.0	16.2	3	28	6.6
<i>Hi.</i>	* 155.0	13.0	1	9	—
(<i>K.</i>	* 136.1	21.6	9	91	24.4)
(<i>M.</i>	* 117.6	12.2	5	50	13.4)

TABLE VI.

Sensorial Reaction to Sound. Dessoir Key.

1	2	3	4	5	6	7
<i>F.</i>	* 313.0	23.2	8	80	28.1	155.8
<i>I.</i>	* 306.0	28.3	3	28	16.7	153.2
<i>W.</i>	* 300.0	23.6	3	27	30.6	139.0
(<i>K.</i>	* 123.3	14.7	9	106	9.6)	
(<i>M.</i>	* 113.7	13.7	4	44	1.5)	

Remarks.—Three sensorial series taken from *I.* gave valueless results, the subject finding a difficulty in handling the key. One series showed a central form of reaction, 182.7σ ; mean variation, 7.5σ . This has not been employed in the construction of Table VI. *Hi.* again gave a central ($*203\sigma$; mean variation, 21.8σ) for a sensorial time, and again declared his consciousness of the nature of the result. He had, throughout, but little practice. The results obtained from *K.* are similar to those of Tables III., IV. Practice brought about no alteration in them. Those of *M.* are parallel with these. *K.* had not had practice with the ordinary reaction-key. *M.* had used neither this nor the lip-key.

We would conclude from our experimentation:

(1) That the new pattern chronoscope requires a thorough testing before its times can be accepted as of absolute value.

(2) That the sensorial-muscular difference is not, as Dessoir thinks, a matter of the form of the reaction instrument. We have obtained the difference with three reaction-keys, involving diversity of muscular action. It averages, in these cases, 90σ , 105.5σ , and $*149.3\sigma$.

(3) That we may confirm the view that not every person is able to function as reaction-subject. Rather is there required for the work a special kind of mental disposition or *Anlage*. If the volitional temperament is unfavorable, practice will have no effect in determining the two types of reaction time; if favorable, Lange's distinction holds even of the first practice-experiments.